

L. L. NARAYANA\* & Digamber RAO\*: **Contributions  
to the floral anatomy of Humiriaceae 6\*\***

L. L. ナラヤナ\*・D. ラオ\*: Humiriaceae の花部解剖学的研究 6\*\*

In the present communication the comparative floral morphology of Humiriaceae is discussed in the light of the information so far available on the floral anatomy of its members, namely, *Sacoglottis uchi* (= *Endopleura uchi*) Huber. Cuatr. (Rao and Rao, 1965); *Vantanea parviflora* Lam., *V. macrocarpa* Ducke., and *V. minor* Benth. (Narayana and Rao, 1969b); *Humirastrum dentatum* (Urb.) Cuatr. (Narayana and Rao, 1973a); *Humiria balsamifera* Jaume St. Hil. (Narayana and Rao, 1973b); *Sacoglottis gabonensis* Urb., and *S. guianensis* Benth. (Narayana and Rao, 1975a) and *Schistostemon dichotomum* (Urb.) Cuatr. (Narayana and Rao, 1975b).

**Discussion**

Comparative floral morphology reveals that Humiriaceae resemble the Linaceae in a number of features (Narayana and Rao, 1966, 1969a, 1971, 1973c, 1974a, 1974b). The quincuncial aestivation of the sepals appears to be a characteristic feature of Humiriaceae (Rao and Narayana, 1965; Narayana and Rao, 1969b, 1973a, 1973b, 1976a, 1976b). Although the sepals in *Humirastrum dentatum* (Narayana and Rao, 1973a) and *Sacoglottis gabonensis* (Narayana and Rao, 1975a) are free, a tendency for the union of sepals is noticed in the remaining species (Rao and Narayana, 1965; Narayana and Rao, 1969b, 1973b, 1976a, 1976b). In *Vantanea parviflora* (Narayana and Rao, 1969b) the limbs of the calyx are completely reduced. In all the species so far investigated (Rao and Narayana, 1965; Narayana and Rao, 1969b, 1973a, 1973b, 1976a, 1976b) there is distinct difference in the size of the sepals, the two innermost are smaller, the two outermost are larger and the remaining one which is inside out, is intermediate. Thus, in the unequal size of the sepals with quincuncial aestivation, Humiriaceae shows similarity to the

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Linaceae (Narayana and Rao, 1966, 1969a, 1971, 1973c, 1974a, 1974b).

The sepals, as in many angiosperms, are 3-traced. Connation between lateral traces of adjacent sepals is seen both in species with gamosepalous calyx like *Humiria balsamifera* (Narayana and Rao, 1973b), *Sacoglottis guianensis* (Narayana and Rao, 1976a), *Schistostemon dichotomum* (Narayana and Rao, 1976b), *Vantanea parviflora*, *V. macrocarpa* and *V. minor* (Narayana and Rao, 1969b) as well as in taxa with polysepalous calyx like *Humiriastrum dentatum* (Narayana and Rao, 1973a) and *Sacoglottis gabonensis* (Narayana and Rao, 1976a). However, in *Endopleura uchi* (Rao and Narayana, 1965) the sepal lateral traces arise conjointly with the sepal midribs. From this it may be inferred that two types of fusion of sepal traces are present in the family. The present study indicates that connation between the lateral traces of sepals preceded the union externally. The adnation between the common sepal lateral traces and petal midribs seen in *Sacoglottis guianensis* (Narayana and Rao, 1976a), is also reported in Linaceae (Narayana and Rao, 1971).

A polypetalous, 5-merous corolla is a common feature in all the species of the family so far studied (Rao and Narayana, 1965; Narayana and Rao, 1969b, 1973a, 1973b, 1976a, 1976b). But there is variation in the aestivation of the petals. They are quincuncial in *Humiria balsamifera* (Narayana and Rao, 1973b) and *Sacoglottis guianensis* (Narayana and Rao, 1976a), imbricate in *Humiriastrum dentatum* (Narayana and Rao, 1973a), *Schistostemon dichotomum* (Narayana and Rao, 1976b) and *Vantanea minor* (Narayana and Rao, 1969b) and contorted in *Endopleura uchi* (Rao and Narayana, 1965), *Sacoglottis gabonensis* (Narayana and Rao, 1976a), *Vantanea parviflora* and *V. macrocarpa* (Narayana and Rao, 1969b). The petals are 3-traced in *V. parviflora*, *V. macrocarpa* and *V. minor* (Narayana and Rao, 1969b) and 1-traced in the remaining species studied (Rao and Narayana, 1965; Narayana and Rao, 1973a, 1973b, 1976a, 1976b). Such 3-traced petals have been reported in other families like Cucurbitaceae (Miller, 1929), Degeneriaceae (Swamy, 1949), Goodeniaceae (Brown, 1816), Myrsinaceae (Saunders, 1934b), Papaveraceae (Dickson, 1935), Primulaceae (Brown, 1816; Henslow, 1890; Arber, 1933; Dickson, 1936), Solanaceae (Brown, 1816; Artschwager, 1918), Theophrastaceae (Saunders, 1934a) and Winteraceae (Nast, 1944). The 1-traced condition of the petals seems to have been derived from a 3-traced condi-

tion seen in the three species of *Vantanea* by reduction of lateral traces. The lateral traces manifest connation in *Vantanea parviflora* and adnation with sepal midribs in *V. macrocarpa* and *V. minor* (Narayana and Rao, 1969b). The adnation between petal midribs and common sepal lateral traces in *Sacoglottis guianensis* (Narayana and Rao, 1976a) thus can be reckoned as an advanced character.

The androecium in all the taxa of Humiriaceae is monadelphous and shows progressive steps of reduction. The multistaminate condition in *Vantanea* species (Narayana and Rao, 1969b) is reckoned as primitive for the family. The larger number and chorisis of staminal traces seen in these species recalls the fasciculate condition of the androecium in the Dilleniales (Eames, 1961; Wilson, 1965). The union of the stamens to form a tube at the base, in spite of the multistaminate condition is noteworthy. The biseriate androecium in the other species investigated (Rao and Narayana, 1965; Narayana and Rao, 1973a, 1973b, 1976a, 1976b) is brought about by reduction in the number of stamens and their trunk cords. In species like *Humiria balsamifera* (Narayana and Rao, 1973b), *Humirastrum dentatum* (Narayana and Rao, 1973a) and *Schistostemon dichotomum* (Narayana and Rao, 1976b), the biseriate androecium of twenty stamens consists of an outer antisepalous whorl of fifteen stamens arranged in five groups of three each and the inner whorl of five antipetalous stamens. The antiseplous staminal traces arise independently in close groups of three each in *Endopleura uchi* (Rao and Narayana, 1965) or as a single trace dividing into three as in *Humiria balsamifera* (Narayana and Rao, 1973b), *Humirastrum dentatum* (Narayana and Rao, 1973a) and *Schistostemon dichotomum* (Narayana and Rao, 1976b). Thus, the triplets delineate reduced stamen fascicles. The inner whorl consists of only five stamens whose traces do not show branching and these represent the median members of the triplets, the lateral members having been suppressed. In *Sacoglottis gabonensis* and *S. guianensis* (Narayana and Rao, 1976a) where there are only five stamens in the outer whorl, it can be inferred that this condition is derived by the elimination of the lateral members of the triplets of the outer whorl. In *Endopleura uchi* (Rao and Narayana, 1965) the lateral traces of the triplets sometimes branch further, thus indicating that the triplets are the ultimate reductions of the stamen fascicles.

In Dilleniaceae, Lauraceae, Paeoniaceae, Cactaceae, the androecium is of the fasciculate type (Eames, 1961) and the number of stamens in a fascicle vary generally and exhibit centrifugal development. A reduction in the fasciculate androecium is seen in several members of the Dilleniaceae and Lauraceae. Eames (1961, p. 105) states that "The formation of fascicles is probably an early step in androecium reduction. Further steps consist of reduction in the number of fascicles and in number of stamens per fascicle". Therefore, the androecium in the Humiriaceae embodies all these evolutionary steps.

An early tendency towards obdiplostemony was observed in *Humiria balsamifera* (Narayana and Rao, 1973b) and *Schistostemon dichotomum* (Narayana and Rao, 1976b) though there are 20 stamens, 15 in the outer whorl and 5 in the inner whorl. Further, while there is no adnation between petal midribs and antipetalous staminal traces in *Humiria balsamifera* (Narayana and Rao, 1973b), in *Schistostemon dichotomum* (Narayana and Rao, 1976b) the antipetalous staminal traces are conjoint with petal midribs. Obdiplostemony is essentially associated with the antipetalous position of the carpels, where their number is isomerous with petals.

It is interesting that in *Humiria balsamifera* (Narayana and Rao, 1973b) the loculi are antipetalous, while in *Schistostemon dichotomum* (Narayana and Rao, 1976b) they are antisepalous. The present study clearly brings out that obdiplostemony need not necessarily be associated with the antipetalous position of the carpels.

In certain species of this family for example, *Humiria balsamifera* (Narayana and Rao, 1973b), *Humiriastrum dentatum* (Narayana and Rao, 1973a) and *Schistostemon dichotomum* (Narayana and Rao, 1976b) each antisepalous staminal trace divides into three branches and there is no branching of the antipetalous staminal traces as in *Fremontia*, a member of Sterculiaceae (Saunders, 1939). Further, while in *Fremontia* the antipetalous staminal traces supply the sterile stamens, in *Humiria balsamifera* (Narayana and Rao, 1973b), *Humiriastrum dentatum* (Narayana and Rao, 1973a) and *Schistostemon dichotomum* (Narayana and Rao, 1976b) they supply the fertile stamens. In other Malvales the antisepalous stamens and their traces sustain reduction.

Hand in hand with the reduction in the number of stamens there is loss of fertility in the microsporangia. In this respect the genus *Vantanea* (Na-

rayana and Rao, 1969b) in which all the four microsporangia are fertile, can be considered primitive. In *Endopleura uchi* (Rao and Narayana, 1965) the outer pair of sporangia are fertile in the lower half, and the inner pair remains fertile in the upper half. Further reduction leading to the complete loss of the sporangia is met with in the rest. The outer pair of sporangia are sterile in *Humiria balsamifera* (Narayana and Rao, 1973b) and *Schistostemon dichotomum* (Narayana and Rao, 1976b); in *Humiriastrum dentatum* (Narayana and Rao, 1973a), *Sacoglottis gabonensis* and *S. guianensis* (Narayana and Rao, 1976a), however, the inner pair of sporangia are sterile. Though there is reduction in the number of fertile sporangia, the connective in all the species is prolonged into an appendage, a feature reported in other families of angiosperms (Subramanyam, 1949; Parkin, 1951; Eames, 1961). Since the vascular trace in the connective is continued into the staminal appendage, the latter can be deliberated as a prolongation of the connective and thus staminal in origin.

While the fasciculate androecium shows gradual evolution towards diplostemony, the ovary presents neither primitive features nor evolutionary steps. The number of carpels is almost constantly five and syncarpy is firmly established in all the species. Occasionally the number of carpels may range from four to eight (Cuatrecasas, 1961). From this the predominantly pentacarpellary condition of the ovary seems to be derived from a condition with more than five carpels. Both three traced and five traced conditions of carpels occur in this family. The former condition is seen in *Humiria balsamifera* (Narayana and Rao, 1973b) and *Vantanea* species (Narayana and Rao, 1969b) and the latter in the rest of the species. The traces supplying the ovary show no adnation. There are two or one ovules in each loculus. Where both ventral carpellary margins are fertile as in *Humiria balsamifera* (Narayana and Rao, 1973b) and *Vantanea* species (Narayana and Rao, 1969b), there are two superposed ovules in each loculus. In *Endopleura uchi* (Rao and Narayana, 1965), *Humiriastrum dentatum* (Narayana and Rao, 1973a), *Sacoglottis gabonensis* and *S. guianensis* (Narayana and Rao, 1976a) and *Schistostemon dichotomum* (Narayana and Rao, 1976b) due to loss of fertility of one of the margins in each carpel, the number of ovules is reduced to one per loculus. The placentation is anatomically parietal in *Humiria balsamifera* (Narayana and Rao, 1973b) and *Vantanea* species (Narayana and Rao,

1969b) and axile in the rest (Narayana and Rao, 1973a, 1976a, 1976b; Rao and Narayana, 1965). The style shows a stylar canal lined by transmitting tissue and is traversed by the dorsal carpellary bundles. In *Endopleura uchi* (Rao and Narayana, 1965) however, only the common median lateral bundles extend into the style.

An intrastaminal disc is present in all the genera of Humiriaceae (Rao and Narayana, 1965; Narayana and Rao, 1969b, 1973a, 1973b, 1976a, 1976b). According to Winkler (1931), the lobed nature of the disc is here a characteristic and distinctive feature. According to Cuatrecasas (1961) the intrastaminal disc in Humiriaceae is free and surrounds the ovary and may be (p. 45) "membranaceous or sub-coriaceous, tubular or cupular, dentate, lobate, lacinate or composed of 10-20 free scales". The floral anatomy of *Vantanea* species (Narayana and Rao, 1969b) particularly, has thrown some light on the morphology of the disc in the family. In this genus the several stamens are united below into a tube and numerous vascular bundles are formed by chorisis of staminal traces. At a higher level the filaments of the stamens separate from the peripheral part of the tube, while the inner part of the tube forms the disc. The bundles in this region represent the supply for the suppressed stamens. This sterilized part of the tube may be united with the base of the staminal tube as in *Humiria balsamifera* (Narayana and Rao, 1973b), *Vantanea macrocarpa* and *V. minor* (Narayana and Rao, 1969b) or the base of the ovary as in the rest of the species investigated (Rao and Narayana, 1965; Narayana and Rao, 1969b, 1973a, 1976a, 1976b). In *Endopleura uchi* (Rao and Narayana, 1965), *Humiria balsamifera* (Narayana and Rao, 1973b), *Schistostemon dichotomum* (Narayana and Rao, 1976b), the disc is vascularized by the branches of the emerging staminal traces. In *Humiriastrum dentatum* (Narayana and Rao, 1973a), *Sacoglottis gabonensis* and *S. guianensis* (Narayana and Rao, 1976a), the vascular supply to the disc is completely suppressed. Thus, the disc in the family Humiriaceae can be interpreted as the inner sterilized part of the staminal tube.

### Summary

The comparative floral morphology and vascular anatomy of the family Humiriaceae is discussed in the light of the information so far available on the floral anatomy of its members. The floral morphological characters

of the family are compared with those of the Linaceae. The sepals are 3-traced and the petals are 1-traced, except in *Vantanea* species where the petals are 3-traced. Connation and adnation between the traces of the floral parts are noticed in the different taxa. The androecium is multistaminate and fasciculate in *Vantanea* and a reduction in the number of stamens is noticed in the other taxa. Obdiplostemony is present in *Humiria balsamifera* and *Schistostemon dichotomum*. There is reduction in the number of fertile microsporangia from four to two in the different species. The lobed or annular, intrastaminal, vascularized disc is interpreted as staminal in origin. Both 3- and 5-traced carpels are present. Placentation is anatomically parietal in *Humiria balsamifera* and *Vantanea* species. On the basis of floral anatomical characters, *Vantanea* is considered most primitive in the family.

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#### Literature cited

- Arber, A. 1933. Floral anatomy and its morphological interpretation. *New Phytol.* 32: 231-242. \*Artschwager, E. 1918. Anatomy of the potato plant, with special reference to the ontogeny of the vascular system. *J. Agric. Res.* 14: 221-252. \*Brown, R. 1816. Some observations on the natural family of plants called Compositae. *Trans. Linn. Soc. London* 12: 76-142. Cuatrecasas, J. 1961. A taxonomic revision of the Humiriaceae. *Contr. U.S. Nat. Herb.* 35: 25-214. Dickson, Jean. 1935. Studies in floral anatomy II. The floral anatomy of *Glaucium flavum* with reference to other members of the Papaveraceae. *J. Linn. Soc. (Bot.)* 50: 175-224. — 1936. Studies in floral anatomy III. An interpretation of the gynoecium in the Primulaceae. *Amer. J. Bot.* 23: 385-393. Eames, A. J. 1961. *Morphology of Angiosperms*. New York. \*Henslow, G. 1890. On the vascular systems of floral organs, and their importance in the interpretation of the morphology of the flowers. *J. Linn. Soc. Bot.* 28: 151-197. \*Miller, W. L. 1929. Staminate flower of *Echinocystis lobata*. *Bot. Gaz.* 88: 262-284. Narayana, L. L. 1964. A contribution to the floral anatomy and embryology of Linaceae. *J. Indian*

- Bot. Soc. 43: 344-357. Narayana, L. L. & Rao, D. 1966. Floral morphology of Linaceae. Journ. Jap. Bot. 41: 1-10. — 1969a. Contributions to the floral anatomy of Linaceae 1: Journ. Jap. Bot. 44: 289-294. — 1971. 2. Phytomorphology 21: 64-67. — 1974a. 3. Curr. Sci. 43: 226-227. — 1974b. 4. Curr. Sci. 43: 391-393. — 1973c. 5. Journ. Jap. Bot. 48: 205-208. — 1969b. Contributions to the floral anatomy of Humiriaceae 1. Journ. Jap. Bot. 44: 328-335. — 1973a. 2. Journ. Jap. Bot. 48: 143-146. — 1973b. 3. Journ. Jap. Bot. 48: 241-246. — 1976a. 4. Journ. Jap. Bot. 51: 12-15. — 1976b. 5. Journ. Jap. Bot. 51: 42-44. Nast, Charlotte G. 1944. The comparative morphology of Winteraceae VI.—Vascular anatomy of the flowering shoot. J. Arnold Arbor. 25: 454-466. Parkin, J. 1951. The protrusion of the connective beyond the anther and its bearing on the evolution of the stamen. Phytomorphology 1: 1-8. Rao, D. & Narayana, L. L. 1965. Vascular anatomy of Humiriaceae. Curr. Sci. 34: 383-384. Saunders, Edith R. 1934a. On carpel polymorphism VI. Ann. Bot. 48: 643-692. — 1934b. Comments on "Floral anatomy and its morphological interpretation". New Phytol. 33: 127-170. — 1939. Floral Morphology Vol. II. Cambridge. Subramanyam, K. 1949. On the nectary in the stamen of *Memecylon heyneanum* Benth. Curr. Sci. 18: 415-416. Swamy, B. G. L. 1949. Further contributions to the morphology of Degeneriaceae. J. Arnold Arbor. 30: 10-38. Wilson, C. L. 1965. The floral anatomy of the Dilleniaceae I. *Hibbertia* Andr. Phytomorphology 15: 248-274. Winkler, H. 1931. Linaceae. In Engler, A. and Prantl, K. "Die natürlichen Pflanzenfamilien". 19a: 82-130.

\* Not seen in original

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Humiriaceae に属する *Sacoglottis* (3 spp.), *Vantanea* (3 spp.), *Humiriastrum* (1 sp.), *Humiria* (1 sp.), *Schistostemon* (1 sp.) を材料にした一連の花部解剖学的研究の知見をまとめた。一般に本科はアマ科に似ているが、その他の比較すべき諸科のデータも文献上から参照した。本科ではがく片はすべて 3-trace であるが、花卉は *Vantanea* では 3-trace であって、他の属では種々の段階でそれが接着・融合して 1-trace になっている。*Vantanea* ではおしべは多数で、これが束生する傾向があるが、他の属では明らかな束生化、一束中のおしべ数の減少の傾向を示している。*Vantanea* ではおしべの 4 個の小胞子のうは皆稔性であるが、他の属では一部が不稔化の路を進



んでいる。これらの事実は *Vantanea* が本科の中でもっとも原始的な性格を有すること、他の属はこれを出発点として引き出されたものであることを示唆する。本科にはおしべ群の内側に花盤があるのが一般であるが、*Vantanea* ではおしべの筒の内方からこの花盤に trace が入っていることから、花盤がおしべ起源であることが推定される。その他花卉とおしべとの位置関係、心皮の trace 数、胎座の様式などにも触れた。

□牧野富太郎：復刻版牧野日本植物図鑑 pp. 1080+29+72+31+12+4, 1977 III, 北隆館，東京，12,000円。昭和15年10月に出た最初の版の復刻版である。本書の内容については今さら述べる必要はない。文章は旧版のままで、今の当用漢字並びに口語文にくらべてひどく古風であるが、それがまた侵し難い威風を以てせまってくるのはまことに不思議である。北隆館もそれを考慮し期待して作ったのであろう。

忠実に旧版を集録しているが、牧野博士自筆の線画3葉（ヒメノボタン、サダソウ、ノヂギク）と、博士米寿の写真、並びに博士の年譜4ページを加えたことは、博士の伝記を知る上に参考となる。なおB5版にやや拡大されている。（前川文夫）

□石川茂雄：青森県の自然 A4判172ページ，北方新社，弘前市，昭和52年4月，4,500円。開拓・伐採・開発によって自然は形を変え、緑も少なくなったとはいうものの、本州最北の地青森県にはまだまだ豊かな自然が残されている。長年弘前大学教授の職にあった著者が、植生調査や実験材料採集のため訪れた県下各地で撮影した写真からカラー167，白黒54を選んだ写真集である。八甲田・十和田，県南，下北，津軽半島，西海岸，弘西山地，弘前周辺の7地区に分けて、最も多い林相と群落の景観，次いで植物の大写し，ごく少数の動物が載せてある。これから変化するであろう自然の一記録として重要であるばかりでなく，大いに見る人の目を楽しませてくれる。巻末31ページにわたる解説は，多数の植生図を入れて各地の植物を説明し風景を案内したもので，研究者や学生にとって非常に有益な記事である。（伊藤 洋）

□神田 淳：写真集日本の野生ラン 194頁内184頁はプレート。1977 II，誠文堂新光社，東京，20,000円。10年余をかけて心血をそそいで撮りためた写真集である。全体を草原で，湿原で，明るい林で，暗い林で，樹や岩の上の5部に分ち，それぞれについて景観図，花の全形図や細かい区分図と種々にとり分けたものがページを追って出て来て，それぞれに眺めて飽くことを知らない。厳密な野生での撮影であるから，生態や生時の微妙な咲き方の相違を知るにも好都合である。ことにコカゲラン (Pl. 133-136)，アオキラン (Pl. 141-142)，ムヨウラン類 (Pl. 150-157) など，なかなか珍しいものをよくうつしてある。またハチジョウシュスランやカゴメランの葉脈の斑の在り方 (Pl. 163-171) などよくわかる。まことにラン科を学ぶのに打ってつけの本である。2月に出版，4月にも第三版を向えたのはいかによく受け入れられたかを示している。（前川文夫）